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OF
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NOVEMBER, 1928

Featuring

**Fast Freight
Transportation**



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JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS

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FAST FREIGHT TRANSPORTATION

BY LAWRENCE RICHARDSON *

(Presented before the Boston Society of Civil Engineers, October 17, 1928)

THE principal development in American railroading in the past few years has been from that of wholesale and retail transportation agents to that of wholesale agents. This has been brought about primarily by the increased use of the motor truck and other automotive transportation. As an illustration, six years ago 35 per cent of the cars of the Boston & Maine Railroad were used in less than carload traffic. Today only 22 per cent of the cars are used in that traffic. The average haul per ton of freight handled in the United States has increased considerably. At the beginning of the century the average haul was 246 miles. By 1926 it had increased to 310 miles. There was also an increase in the car load, owing to the reduction in the number of light L.C.L. cars. The average in 1926 was 27.35 tons against 23.38 in 1915.

The increase in business has been marked. In 1919, 367,000,000,000 ton miles; in 1924, 391,000,000,000 ton miles; and in 1926, 447,000,000,000 ton miles were handled in the United States. This increase in business was handled with no increase in track mileage. There are 396 less miles of railroad in the United States today than there were ten years ago. In 1919 there were 2,426,889 cars; in 1926, 2,403,961. The number of locomotives has also been reduced. There are 2,839 less locomotives now than there were in 1924. The railroads are doing 22 per cent more business with 9 per cent fewer cars.

* Mechanical Superintendent, Boston & Maine Railroad, Boston, Mass.

The Boston & Maine has reduced the number of its locomotives from 1,120 in 1923 to 850 in 1927. It has dropped from its lines 12,000 cars from 1923, when there were 35,000 cars on line. Today there are but 23,000 cars in service. This has been possible because of the fact that it is increasing more and more its wholesale transportation, and is doing less and less retail transportation.

This growth in transportation has been better handled by several means, — first, by better and faster power. As an illustration, a representative locomotive of 1906 produced 8,810 gross ton miles per ton hour; in 1916 the figure was 12,490 tons; today it is almost 20,000 gross tons per train hour. The locomotive of today is producing two and one half times as much as it was twenty years ago.

The principal change that has taken place in the design of the modern locomotive is that they have been built for efficiency and sustained power rather than brute strength. In 1921 the locomotive used 5.66 pounds of coal per drawbar horse power; in 1922, 4.44; in 1925, 2.98. The introduction of time and a half for overtime and the demand for faster and better transportation has hastened this increase in efficiency. The development of heavier rail has made possible the utilization of heavier power. The Boston & Maine is now planning to install 130-pound rails in its main line track. Developments in the yards have equalled, if not exceeded, those on the road. Four miles of yard track are required for every 7 miles of main line. Generally the 4 miles of yard track are more valuable than the 7 road miles. On the Boston & Maine there are 43 yards and 104 junctions, or a junction point every 20 miles. The longest haul is only 209 miles. That is eastward from Rotterdam Junction to Boston.

Several years ago the Storrow Committee investigated the freight movement on the Boston & Maine from Rotterdam Junction to Boston. At that time it estimated that the average time was 143 hours. The committee thought that there might be a possible reduction to 51 hours. Today the Boston & Maine is doing it in 18 hours. Since the application of the car retarder in the yards trains now spend only from $1\frac{1}{2}$ to 2 hours at Mechanicville, and only from 1 to $1\frac{1}{2}$ hours in Boston. The trains are inspected in 13 or 14 minutes, humped in 15 minutes. The classification does not take over half an hour. That is speed. It was necessary to spend a considerable sum of money in order to bring about this increased operating efficiency. The 1928 budget was \$10,000,000. Over \$17,000,000 is anticipated next year. The net result in improvement in freight transportation has been the increase in car miles per day of 53 per cent, — from 16.8 in 1920 to 25.7 per cent in 1928, and a decrease

in unserviceable cars, from 8.9 to 5 per cent, or a decrease of 43 per cent. The gross ton train increase was 35 per cent.

There has been a drop in operating revenue of \$4,000,000, but the corresponding drop in operating expense has been \$9,000,000, so the drop in revenue has been more than offset.

CAR RETARDER YARDS*

One of the important operations in railway transportation is the sorting or classifying of cars at division or terminal yards. During the past twenty-five years the so-called hump yard has been generally conceded to be the most economical means of classifying cars. The hump yard has one or two tracks on an ascending grade to a summit, over which a train of cars is pushed by a humping engine, usually at a speed of two to four miles per hour. The cars are uncoupled or "cut" by the conductor of the humping crew just before reaching the summit, and then run by gravity down the far side of the hump into the proper classification track. On gravity humps car riders or brakemen control the speed of the cars down the hump and ladders to prevent them from running into other cars standing on a classification track at a speed that might damage cars and lading. Two miles per hour for loads, and a corresponding higher rate for empties, is considered as a safe coupling speed. The riders climb on the cars before reaching the hump, one to each car or group of cars, known as a "cut," try the brakes to see that they are operating properly, ride the car until it reaches its classification track, and, after checking the speed of the car to about three miles an hour, either walk back to the hump or are carried there by a motor car on a special track. A considerable part of the car rider's time is therefore spent in returning to the hump, and unless traffic is fairly uniform he also spends much time waiting for trains to be humped. Obviously the capacity of a yard depends upon the number of riders available. Where traffic is uniform it is not difficult to provide a suitable number of riders, but where traffic varies greatly, as is the case in most yards, it would not be economical to provide a sufficient number of riders to handle peak periods promptly. During such periods it is necessary to wait for riders, while at other times the riders are idle.

The number of cars that can be handled by a rider in a day, or an eight-hour trick, varies considerably, depending on the length of the

* The section of this paper on Car Retarder Yards was originally presented by Mr. Richardson at the New England Industries Meeting of the American Society of Mechanical Engineers, held at Boston, Mass., October 1, 2 and 3, 1928.

classification tracks, on whether he walks or rides back, and on the average number of cars per cut. From 25 to 50 cars per rider is the usual practice. A car rider's wages are about \$7 for an eight-hour trick.

Ordinarily track switches are thrown by switch tenders, the number depending on traffic. In some yards the switches are power-operated and are controlled from a lever machine at or near the hump. The number of eight-hour tricks worked per day, as well as the number of engine crews on each trick, also depends upon traffic.

USUAL ARRANGEMENT OF CAR-RIDER YARD

The usual hump yard has one or two tracks from the hump and one or more ladder tracks, along which at regular intervals are the classification-track switches. This arrangement is essential with hand-operated switches so that the switch tenders can walk or run along the ladder tracks and seldom have to cross tracks.

Grades vary greatly, but it is usual to have a short stretch of 3 or 4 per cent just below the hump and then 1 per cent extending some distance into the yard. In some cases the 1 per cent grade begins at the hump and extends nearly to the end of the yard.

The height of a hump can be computed approximately, and then raised or lowered until it is suitable for the requirements of the yard and for the character of the traffic handled. In general, a higher hump is required for empty cars than for loads, and also for winter conditions as compared with summer ones. In some yards the height of the hump is increased a foot or two before winter begins, and lowered the same distance in the spring. In other yards two humps are provided, — a high one for winter and a low one for summer.

The disadvantages of car-rider operation are as follows:

Unsuitability for sudden peak demands.

Cost of riders, switch tenders, and other employees.

Personal injuries to employees.

Damage to cars and lading.

Pilferage of cars by riders and other employees at night.

Cleaning yard of coal, etc., falling from cars.

DEVELOPMENT OF THE RETARDER

In order to reduce the cost and to eliminate the hazard of hump operation, experimental tests were conducted by President Hannauer of the Boston & Maine (then vice-president of the Indiana Harbor

Belt) and his associates at their Michigan Avenue car shop with a device for the retardation of cars moving on tracks.

The principles developed here were then applied in a retarder placed on the west-bound Gibson hump on September 15, 1923, consisting of two 40-foot sections at the foot of the incline of the hump. These machines were first operated by four-way air valves from a central point, they being placed in a small building at the foot of the hump, and later by electropneumatic valves. The latter displaced the hand throw and simplified the work of the retarder operators, making it possible for them to handle the cars with greater rapidity.

The first tests were successful, but the question then came up as to the action during extreme cold weather, especially when accompanied by snow. These tests were continued later in 1923, during cold weather

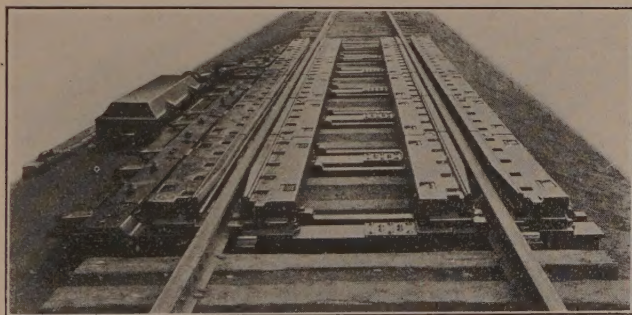


FIG. 1. — HEAVY-DUTY ALL-ELECTRIC CAR RETARDER

and snowstorms, and as no adverse effect was noted in the operation, this led to further installations early in 1924. Operation was then continued with four retarders, other units being added, until in December, 1924, the westbound yard was completely equipped.

The first retarders were constructed from convenient railway materials, such as car springs and brake cylinders. Refinements in design have progressed to the point where practically every member has been designed for the required service and manufactured accordingly.

The car retarder (Fig. 1) is a track brake which presses against both sides of the lower part of the car wheels in the same manner as a vise, the pressure being controlled by an operator according to the weight and the speed of the car, — heavy retardation for a heavy load and little or no retardation for an empty. There are two types of car-retarder systems in service on the railways of the United States, — the all-electric

system, in which retarders, switch machines, and skate machines are controlled and operated by electric energy, and the electropneumatic system, in which similar units are controlled by electric energy and operated by compressed air.

DETAILS OF RETARDER CONSTRUCTION

The shoe beams are of special alloy steel, 5 feet 6 inches long, articulated to prevent binding due to variation in the grade of the track. The top of the brake shoe is 2 inches above the top of the rail. The wheel space is 7 inches open and 4 inches closed. Every third tie is a steel

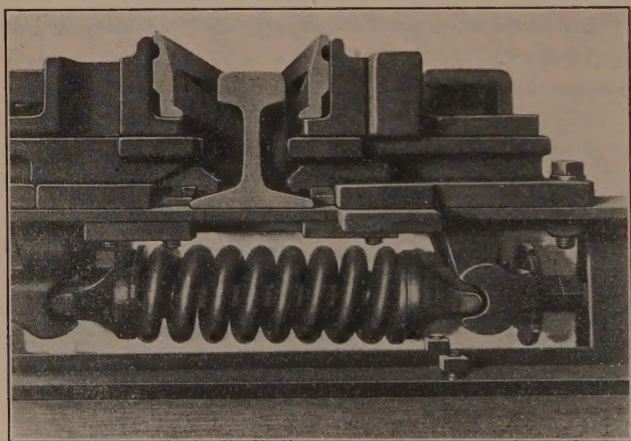


FIG. 2. — END VIEW OF RETARDER, SHOWING HEAVY SPRINGS

I-beam. Car retarders are ordinarily 33 to 40 feet long. The latter is the maximum length operated by one mechanism; if greater lengths are required, two or more units are used. The weight of a 33-foot retarder and mechanism is approximately 16 tons, and of a 38-foot 6-inch retarder, approximately $18\frac{1}{2}$ tons. The construction of a retarder is such that there is little chance of any dragging car equipment's fouling the retarder, and also a derailed car could do little damage, owing to the heavy and substantial parts, capable of bearing the weight of a car or a locomotive. The cranks are mounted in heavy longitudinal members bolted to the ties. The long arm of the crank is attached to a longitudinal operating bar, which is connected to the mechanism. The short arm of the crank is connected to cross-members which operate

the spring mechanism under each rail. There are 12 sets of springs for the 33-foot retarder, and 14 sets for the 38-foot 6-inch retarder. Each set has two springs, making a total of 24 and 28 springs, respectively. Fig. 2 is an end view of a retarder member, showing the heavy springs, and Fig. 3 shows a complete electropneumatic retarder.

All forces are self-contained in the mechanism. Under extreme conditions the maximum stress in the members is not over 30,000 pounds per square inch, and under normal conditions about 15,000 pounds. Wood ties are 8 x 12 inches, usually of creosoted oak; similar ties 4 x 10 inches provide a good bearing for the steel ties.

In an all-electric retarder the mechanism case is bolted to a longi-



FIG. 3. — ELECTROPNEUMATIC RETARDER

tudinal angle and two ties near the middle of the retarder. It houses a 230-volt 5-horsepower motor with suitable gear reduction, a powerful brake that holds the motor stationary and is released only when power is applied to the motor, and a master circuit controller consisting of five sets of contacts, or one set for each position of the lever in the control machine. Control circuits are 115-volt, and operating circuits, 230-volt. For simplicity and for economy in wire the operating circuits are local, and the master circuit controller in the mechanism controls heavy-duty forward and reverse contactors in a separate housing at the main power line, usually within 50 or 60 feet of the retarder. In connection with the heavy-duty contactors there is a time element device that opens the operating circuits in case of excessive current if the motor stalls,

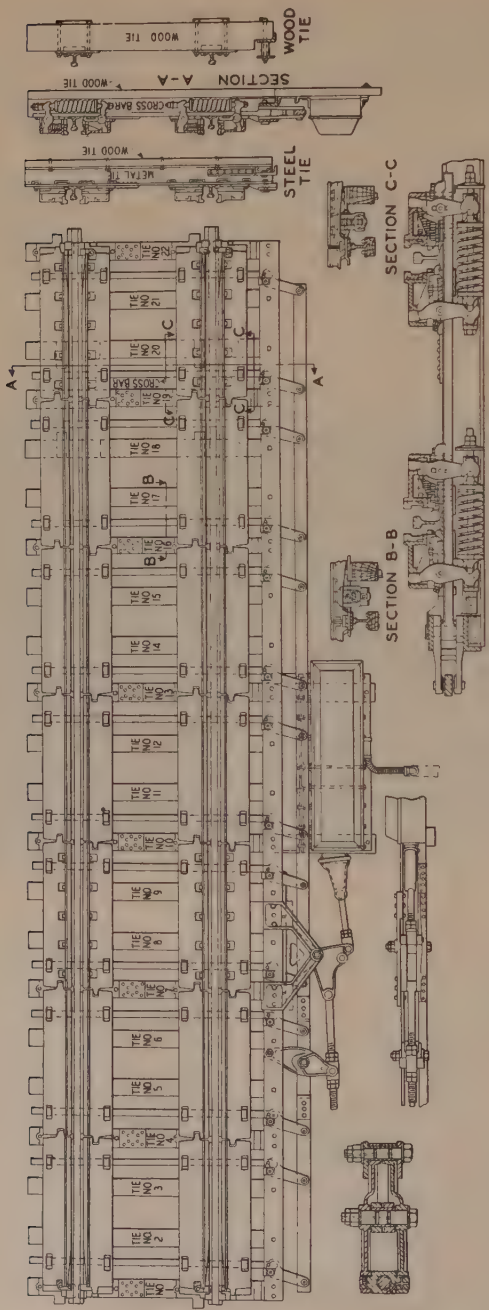


FIG. 4. -- PLAN OF ALL-ELECTRIC RETARDER

thus preventing injury to the motor. A fused knife switch is provided to cut off power during inspection or maintenance. The plan of an all-electric retarder is shown in Fig. 4.

The mechanism is attached to the longitudinal operating bar by means of a toggle arrangement, as shown in Fig. 5, which produces a fast movement when the retarder begins to close and a slower movement with enormous pressure near the closed position. The fast movement near the open position affords a quick release. The diagram also shows the spring mechanism and connections which afford equalization of shoe

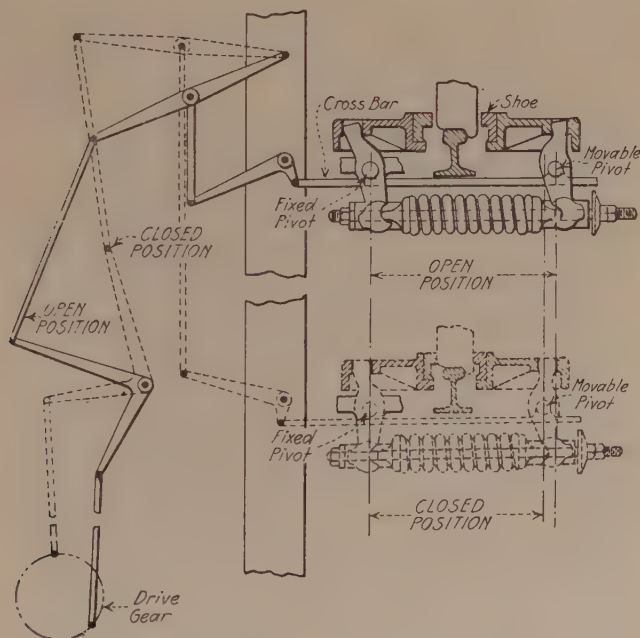


FIG. 5. — DIAGRAM SHOWING QUICK-CLOSING PRINCIPLE

pressure and compensate for variations in the width of the wheels and of the track gage. This feature largely eliminates the possibility of lifting light cars through the application of heavy pressure. Should by any chance a car be lifted, the inner shoes serve as guard rails, and the car would drop back on the rails on clearing the retarder.

In the electropneumatic type the air-operating cylinder is mounted parallel to the track. The air pressure is controlled by electrically operated valves and is transmitted by a "live-lever, dead-lever" arrangement similar to the foundation brake gear of a freight car, through

bell cranks and springs to the retarder shoe. The pressure is graduated in four steps, and release is accomplished pneumatically, requiring only half the amount of air needed for application, owing to the trunk-piston construction used. Working pressures run as high as 80 to 110 pounds per square inch.

To take care of wheel-dimension variations very heavy springs are used in the final transmittal of pressure to the shoes. Ample margin is provided so there is no danger of their breaking when subjected to heavy-duty service.

The general practice in handling cars is to set the proper degree of retardation in each retarder before the car reaches it, as this requires



FIG. 6. — CONTROL FOR RETARDERS, SWITCHES, AND
SKATES

much less current, and also causes less wear on the parts. In some emergencies it is necessary to close a retarder with a car passing through it, usually where proper retardation has not been given in preceding retarders, but this should be avoided if possible.

CONTROL MACHINE

The control machine (Fig. 6) consists of a compact steel cabinet with a sloping top divided into panels, which can be raised for inspection of the apparatus. On each panel there is provision for retarder

levers, switch levers, skate switches, lever lights, and the name plates for the levers. Each machine has levers for the particular requirements of track layout and retarders. The lever lights, when illuminated, show the operator that the retarder has operated to the corresponding position of the retarder lever. The retarder lever in the all-electric machines has six positions, — power off, retarder open, and four degrees of retardation, all of these positions being numbered. The electropneumatic machines have as high as five degrees of retardation, those in Boston having four. The machine and operator are shown in Fig. 7.



FIG. 7. — MACHINE AND OPERATOR IN TOWER

Small lights, usually placed just above the switch lever, indicate the normal and reverse positions of the track switches. Where track circuits are used, there is a light for each one which indicates whether a car is on the circuit. With track circuits it is impossible to throw a switch under a car. Ordinarily the retarders are operated to the proper position before a car reaches them, — strong retardation for a heavy car, and little or none for an empty, as this requires much less current than when a retarder is closed with the wheels of a car therein. In the

lower part of the cabinet is a terminal board with panels on which are mounted the main switches, bus bars, fuses, and terminals.

There is usually one lever machine in each control tower, but where two operators work during peak hours, two lever machines of half the size are provided. In most yards two or three control towers are adequate. The determining factor is the number of retarders, switches, and skates that one operator can efficiently handle. The towers should afford a clear view in all directions of that part of the yard controlled from each, so that the operator may observe the speed of the cars and their relative positions. One tower is some distance below the hump and one or more towers are beyond, on one or on both sides of the yard.

POWER EQUIPMENT

The power equipment varies according to the commercial current available and the specifications of a particular railroad, but a typical installation is as follows: Two 25-kw., one 3-kw., and one 1-kw. a.c.-d.c. motor-generator sets, one 240-volt 160-amp. storage battery, and switchboards with control apparatus, switches, meters, etc. Power for operation of the retarder system is furnished by the 25-kw. motor-generators, which are usually operated on 440 or 550 volts a.c. and which deliver 230 volts d.c. Two are installed, one being in regular use while the other serves as an emergency unit. The 1-kw. set is used for trickle-charging the storage battery, and the 3-kw. set to charge at a higher rate when necessary, it being possible to charge by both sets connected in multiple. In case of failure of the commercial current the load is automatically switched to the storage battery, which latter will operate the plant for some time.

The power plant for the electropneumatic type is more simple, consisting of compressors, usually motor-driven, and 6-volt battery circuits for the control. The air capacity is not determined by the number of retarders, but by the number of switch and retarder movements. The power equipment is housed in a small building near the center of the load, or in a lower story of one of the towers. Motor-generators, compressors, and switchboards are placed in one room, and the storage battery in a separate room, so as to avoid injurious effects from the sulphuric-acid fumes.

The power required varies with the number of cars handled and other conditions. Figures obtained from one of the first retarder installations show approximately 0.04 kw.-hr. per car. Assuming that 1,000 cars are handled per day, and that current costs \$0.03 per kw.-hr., the monthly cost of power would be approximately \$37.20.

SWITCH-OPERATING MECHANISMS

The switch machines which operate the track switches are similar to the switch machines used in electric interlocking, the difference being that some of the protective features not required for low-speed yard operation have been eliminated. Each switch is operated from normal to reverse position or *vice versa* from a two-position lever in the control machine. The operating time is about one second, which is well under any requirements. The position of the switch is indicated by two lights on the control machine, one light indicating normal position and the other the reverse position. The switch machine follows instantly the position of its control lever. The switch machines are either electropneumatic or all-electric.



FIG. 8. — ELECTROPNEUMATIC RETARDERS AND SWITCH
MACHINES

The latter operate on 115 volts, one side of the circuit being connected to the 230-volt power line, and the other to the neutral wire. A two-indication color-light signal is usually installed at each switch, as shown in Fig. 8, which not only indicates the position of the switch, but serves as a location marker, which is of considerable assistance to the operator at night in spacing cars from the hump. It is the practice of some railroads to install detector track circuits at each switch to prevent the throwing of a switch under a train, essentially the same as in interlocking practice. However, this has a tendency to slow up operation. With well-drilled operators it is not felt that this protection is warranted.

SKATE AND SKATE MACHINE

The skate (Fig. 9), although solely a safety feature, is used on a number of retarder installations, being placed on each track just beyond the frog at the clearance point. The skate is used only in the emergency of a car leaving the last retarder at too high a speed, which might result from improper handling by one or more operators, or in the case where a loaded car was improperly designated as an empty on the operator's list. The skate consists of a steel casting with its upper surface curved, the base of the skate fitting into a supporting frame which is connected



FIG. 9. — SKATE-PLACING MACHINE

to a simple mechanism in such a manner that the skate is raised from its normal horizontal position beside the rail to a vertical position on the rail. The skate machine operates similarly to the switch machine, and is controlled by means of a switch on the control machine.

HUMPING TRIMMER SIGNALS

Engine movements in the yard are controlled by two or more color-light signals, each of which indicates in both directions. One signal at or near the crest of the hump is controlled by the hump engine con-

ductor, who cuts off the cars as they are pushed up the hump grade; the other signals repeat the indications of the hump signal, and are located along the hump lead so that an indication is always visible ahead of the humping engine, regardless of the length of the train. The aspects and indications vary among the railroads, but the following are typical:

SIGNALS FACING NORTH OR WEST

Color	Indication
Red	Stop.
Yellow	Proceed at normal humping speed.
Two yellow	Proceed at fast humping speed.
Green	Proceed at normal yard speed.
Yellow over red	Back up.

SIGNALS FACING SOUTH OR EAST

Color	Indication
Red	Engines in classification yard remain in clear; humping is proceeding.
Green	Humping has ceased; engines in classification yard may come out on lead.

The first set of indications governs humping operations, and the second set, trimming or similar operations. In yard parlance the term "trimming" refers to the pushing into the clear of cars that may foul other tracks, also to pushing cars to the far end of the classification tracks so as to make room for additional cars. In some yards the necessary trimming is done by the humping engine after it has humped a train, and in other yards by another engine known as the trimmer engine, which stands by during humping operations.

The control of the humping signal and repeater signals is such that the operator in the first tower can at all times cause the display of a stop indication in cases of emergency, and in such cases the hump conductor must put his control lever to the stop position before he can give proceed indications. For the information of the operator the indications of the hump signal are repeated in the first tower.

WIRE AND WIRING CIRCUITS

The control and operating wires in some cases are placed in wood or concrete trunking supported on wood or concrete stakes, and in other cases they are in the form of cable buried in the ground. The advantage of the trunking arrangement is that the full length of all wires is easily available for inspection in case of trouble. The chief advantage of the cable is that it is out of sight below ground and is not subject to damage by derailments, workmen, etc. There is some question as to which arrangement is the more economical, but both are extensively used.

The wires and cables are usually in accordance with the specifications of the American Railway Association, Signal Section, as car-retarder plants are usually installed by or under the direction of the signal department, as well as being maintained by that department.

AUXILIARY APPARATUS

Some of the auxiliary features in a retarder yard, and which are also used in car-rider yards, are as follows:

1. Teletype system, by means of which typewritten lists of cars and their weights are transmitted simultaneously from the yard office to the hump, all towers, and other points where required. Pneumatic tubes are sometimes used for distributing lists.

2. Loud-speaker telephone system, with transmitters and receivers at the hump and each tower, so that the conductor at the hump and the tower operators can communicate with each other easily and quickly.

3. Short-wave radio apparatus for communication between the conductor at the hump and the engineer of the humping engine. A trial of this system has given satisfactory results on one important installation (Selkirk Yard, New York Central), where 125-car trains are humped.

4. Flood lighting, essentially the same as in any hump yard for night operation, but arranged with respect to the view of the retarder operators.

5. Track scales, when required, the same as in any hump yard.

6. Mechanical hump, which provides means for raising or lowering the hump to compensate for the different running of the cars in winter and in summer. With a hump high enough for the worst condition, as an empty car on a cold winter day, and with sufficient retarders, a mechanical hump is unnecessary, and one has not been included in a retarder installation since 1926.

7. Hot-oil plants to apply hot oil under pressure to car journals in cold weather to cause the cars, especially the light loads and the empties, to roll freely and so not to delay operations.

HOW RETARDER SYSTEM OPERATES

Retarder, switch machines, and skates are controlled from two or three towers (sometimes four or five towers in very large yards) at suitable places, and the operator in each tower controls all the retarder switches and skates in his section.

When humping operations are not in progress, the jaws of the retarder are open so that engines and cars can pass through them freely. As each cut leaves the hump each operator sets the several switches in position to line up the respective route, and then sets each retarder at one of its four degrees of retardation, — in general, heavy retardation for a heavy loaded car and little or no retardation for an empty car. The proper amount of retardation at each retarder depends upon the weight and speed of a car or cut, the necessary spacing to prevent fouling of cars, and the destination of the following cuts. With cars of similar weights a close spacing can be maintained. The most unfavorable condition is a heavy load followed by an empty proceeding to adjacent classification tracks, as it is necessary to apply considerable retardation to the former to prevent acceleration and to allow the empty to proceed with little or no retardation so as not to stop it on the leads and block the yard. Such a case is properly handled by providing a suitable time interval at the hump.

After handling the cars through several retarders they are finally let out of the last retarder at a speed of about three miles an hour on a non-accelerating grade, and at which speed they may bump other cars standing on the same track without damage to cars and lading. The retarder operators quickly become expert in handling the cars under all conditions, and there are records of some remarkable performances where 150 to 200 cars have been humped in an hour.

CYCLE OF OPERATIONS IN RETARDER YARD

The operations in a retarder yard vary somewhat according to conditions, but the following are typical:

1. Incoming train arrives at receiving yard.
2. Waybills are delivered to yard office.

3. Inspection of train by yard force; bad-order cars are so indicated and are later switched from the train.

4. Lists showing car numbers, information as to weights (L indicating load, LL for heavy load, E for empty, etc.), and track number or classification to which cars are destined, in the same sequence as the cars stand in the train, are simultaneously transmitted to each retarder operator, to the yard conductor at the hump, and to other points about the yard as required, by means of the teletype machine or pneumatic tubes.

5. Hump engine is coupled to rear of train, and as soon as humping signal is displayed, pushes the train up the hump.

6. Hump conductor cuts off cars at hump in accordance with teletype list.

7. Retarder operators set switches and retarder in proper position in accordance with teletype list, checking each cut as handled. In cases of emergency the operators also set the skates to stop a car that has left the last retarder at too high speed.

8. Hump conductor gives special information or instructions to operators by means of loud-speaker telephone system.

9. When train is humped, the humping engine and crew do any trimming that is necessary, and then return to receiving yard for another train, or engage in other switching operations if there are no trains in receiving yard.

10. Outbound train made up at the far end of classification tracks, leaving from one of the classification tracks or in some cases from a departure yard.

Only part of the time of the humping engine and crew is spent on humping or trimming, the rest of the time being spent in making up trains, delivering transfers, and in miscellaneous switching operations about the yard, in which the retarder operators often serve as part of the crew.

OPERATING AND MAINTENANCE FORCE IN RETARDER YARD

The operating force in a retarder yard comprises one or two engines, each with engineer, fireman, conductor, and two brakemen; a retarder operator in each tower; and the usual yard staff of yardmaster, assistants, clerks, etc., as in any yard of similar traffic conditions.

The maintenance force, under direction of the signal department on account of its being familiar with similar apparatus, usually is made up of a maintainer on each trick during which humping takes place and two helpers on the day trick. The helpers are usually yard section men

assigned to the oiling of retarders for a part of their time. The number of maintainers depends upon the size of the plant, traffic conditions, and method of operation, but one maintainer always should be available during humping operations in case something should go wrong.

Maintenance work includes the frequent lubrication of retarders and other mechanism; the replacement of worn retarder shoes, they lasting from several months to a year or more, depending upon their location in the hump, or intermediate, or on classification tracks as well as on the traffic; adjustment to compensate for shoe wear; and the routine inspection and care of the apparatus.

ARRANGEMENT OF TRACKS AND GRADES

The maximum capacity of a retarder yard is attained with a group of retarders on each classification track, but the cost of such an arrangement would be very high, and the capacity afforded would be far in excess of reasonable requirements. It is therefore the practice to design an arrangement for the particular requirements, and as economy of installation requires a minimum number of retarders, one group of retarders usually serves from three to seven or more classification tracks, according to traffic, number of classification tracks, and other factors.

A typical arrangement is as shown in Fig. 10, in which six leads radiate from the hump lead, and each lead serves six classification tracks. There are three groups of retarders: first, the hump, which controls the speed of cars at the junction switch and as used also to space adjoining cuts; second, an intermediate group, which checks the acceleration of cars or cuts on the comparatively steep grades; and third, the final group which reduces the speed to about three miles an hour. The speed of cars through the throat of the yard depends upon the retarding value of the last group. In Fig. 11, the Mechanicville yard of the Boston & Maine Railroad, there is shown a total of 17 retarders, or about one retarder to two classification tracks, which is a very efficient arrangement. In order to have each car or cut from the hump reach the clearance point in each classification track in the shortest possible time, within the limits of possible humping speed, it is obvious that the distance from the crest of the hump to the clearance point in the classification track should be a minimum. One method of shortening this distance is the use of lap switches, which also tend to reduce the number of feet of retarders required. Track scales, also any switches on the hump lead, tend to increase this distance and to increase the number of feet of retarders.

GRADES THAT ARE RECOMMENDED

The hump and grades recommended by the American Railway Engineering Association, or a modification of these, are ordinarily suitable for retarder yards. For yards in the northern part of the United

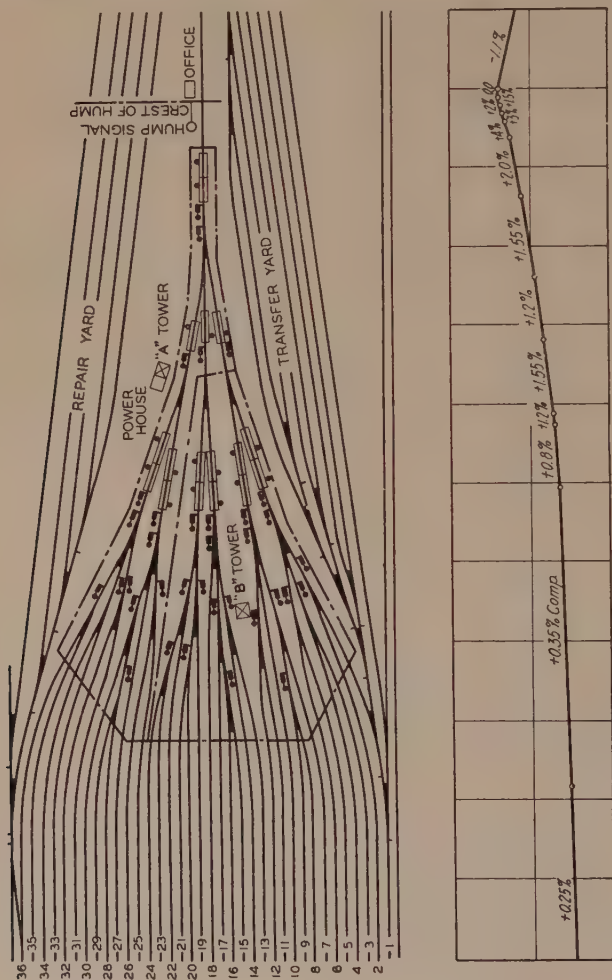


FIG. 10. — TRACK PLAN AND PROFILE OF HUMPH

States, where there is considerable cold weather in winter, the hump grade should be 4 per cent, 1 to 1.5 per cent on leads, and 0.25 or 0.30 per cent from last retarder down nearly to the end of the classification



FIG. 11. — HUMP CLASSIFICATION YARD AT MECHANICVILLE, BOSTON & MAINE RAILROAD

tracks; 0.30 per cent is generally assumed as a non-accelerating grade for average conditions, but is subject to considerable variation.

Car friction varies greatly with the type of car, the weight of car, and lading, the temperature, condition of the bearings, the wind pressure, the speed, and the grade, running from 0.25 per cent (5 pounds per ton) for loads to 1.50 per cent (30 pounds per ton) or more for empties. It is a simple matter to provide suitable hump and grades for a yard handling all loads or all empties, but as most yards handle both empties and loads, it is necessary to provide for them, or delays in operation would result.

A most unfavorable condition is handling an empty car on a cold winter day. The other extreme is a heavy load on a warm summer day. With mixed traffic, empties, and loads, car retarders afford a simple means of compensating for the difference with a hump of sufficient height to handle an empty car in winter. At several busy retarder yards hot oil under pressure is applied during cold weather to the car journals just before the cars reach the hump, the journal-box lids being raised by the car inspectors in the receiving yards. This method is very satisfactory and prevents the slowing up of operations by a car stalling on one of the leads and the resulting delays which would be critical during peak periods. The journals are warmed somewhat while the train is run from the receiving yard to the hump, which is often some distance; but in very cold weather it is sometimes necessary to run the cars back and forth before humping them.

Curves impose additional car friction. For main-line trains at usual speeds curve resistance is usually assumed to be equivalent to a grade of 0.04 per cent (0.8 pound per ton) per degree of curve. Grades are sometimes compensated accordingly, especially through the turnouts beyond the last retarder.

The rapid progress in the adoption of the retarder is owing in a large measure to the handsome economies effected. The first installation at Gibson cut the cost per car from 83.6 cents in February, 1924, to 50.8 cents in February, 1925. The savings effected at Mechanicville are shown in the following statement:

	1927 Two Months	1928 Two Months
Cars received	50,193	51,298
Freight pay roll (dollars)	56,621	30,961
Cost per car (cents)	112.8	60.4
Locomotive repairs (dollars, decrease of)	—	3,151
Fuel (dollars, decrease of)	—	4,355
Hostling (dollars, decrease of)	—	887
Total saving for two months (dollars)	—	34,053
Total saving per year (dollars)	—	221,312

ECONOMY OF RETARDER OPERATION

The principal economies resulting from retarder operation may be summarized as follows:

1. Reduction in engine and crew hours. In most yards the humping engine and crew spend only part of the time on humping operations, and the rest on making up trains, delivering transfers, or on miscellaneous switching operations. This makes it possible to effect a considerable reduction in the engine hour per day.

2. Retarder plant available for maximum traffic twenty-four hours per day.

3. Various flat switching operations at adjacent points or at several stations can be done at the retarder yard, and often make a large reduction in engine and crew hours.

4. Elimination of car riders, switch tenders, and other employees, and of injuries to these employees.

5. Reduction in damage to cars and lading. On account of the facility of controlling cars by retarders, the humping or coupling of cars at excessive speed is eliminated.

6. Reduction or elimination of pilferage, which is often a big item, especially at night, in a large yard with many car riders and switch tenders.

7. Reduction in labor of cleaning yard. Much coal and similar commodities are shaken from cars on account of coupling at excessive speed.

8. Reduction in the average time required to handle a car or train in the yard. This also tends to reduce the elapsed time between terminals, and thus results in more economical operation on the entire division.

9. Quicker deliveries to shippers. In several cases this has been the subject of favorable comment to railway officials by large shippers.

10. Elimination of accidents and delays resulting from defective brakes. In car-rider yards defective brakes often are not detected until after a car has passed over the hump, in which case the rider is helpless and the car crashes into other cars, damaging both cars and lading, and delaying operations until the wreckage can be removed.

COST OF RETARDER INSTALLATION

The cost of a retarder installation varies considerably with the number and gross weight of the cars handled, the height of hump necessary, revision of track layout and grades, and other factors. Also on account of the difference in conditions each yard requires a special study in order to determine whether a retarder installation would be economical. Ordinarily the possible reduction in engine and crew hours is the chief determining factor.

In planning new hump yards for either rider or retarder operation the track layout and grades should be arranged as for retarder operation, which is more efficient and economical than the usual rider hump yard by reason of the short distance from the hump to the clearance point in the classification track, which naturally shortens the time and the distance required for riders to return to the hump. A yard so constructed and operated at first with riders could easily be equipped for retarders and with minimum expense.

CONCLUSION

The car retarder is one of those modern time and labor saving devices that have enabled the railways to reduce operating expenses in spite of rising costs of labor and materials. Although the retarder is a recent development, the first commercial installation in the United States was put in service in February, 1926, and nearly all of the apparatus of this first installation is still in service. The design of this first apparatus has been substantially improved, based upon careful observations under service conditions, and the improved design, which has been in service nearly a year, amply meets all requirements, showing that the retarder has successfully passed through the development stage and is now generally considered as an approved device for the efficient and economical operation of hump yards.

MODERN POWER

In fast freight transportation the modern locomotive is the most important factor. Some years ago the unit of measurement of transportation was simply "gross ton miles" without any specific reference to the time element involved. With changed traffic conditions, it became vital to consider the time element. Quicker deliveries demanded increased train speed. Increased train speed with no reduction in tonnage required higher power output from the locomotive. As the time element became such an important factor, a new unit of measurement "gross ton miles per train hour" came into existence. It is a unit showing the rate at which freight transportation is handled. It is a yardstick for measuring railroad capacity.

The new 4,000 type locomotives on the Boston & Maine (Fig. 12) are especially designed for power, and fully equipped with specialties required for economical operation. They are designed for 250 pounds steam pressure and provided with 100 square feet of grate surface. They are equipped with centrifugally driven feedwater heaters, maximum surface superheaters, underfeed stokers, trailer boosters and cross compound air pumps.

The more important dimensions of the locomotives follow:

Cylinders: 28" diam. x 30" stroke; drivers: 63" diam.

Tractive power (without booster): 68,400 lbs.

Tractive power (with booster): 81,400 lbs.

Boiler pressure: 250 lbs. per sq. in.

Heating surface (evaporative): 5,131 sq. ft.

Superheating surface: 2,111 sq. ft.

Firebox: 150 $\frac{7}{8}$ " x 96 $\frac{1}{4}$ " grate area: 100 sq. ft.

88 2 $\frac{3}{4}$ " diam. tubes.

204 3 $\frac{1}{2}$ " diam. flues — for superheater pipes.

Tubes and flues, 20 ft. long.

Boiler shell 88" diameter at front end.

Total wheel base 80' 3 $\frac{3}{4}$ ".

Rigid wheel base (driving wheels) 16' 6".

Length over couplers, engine and tender, 91' 10 $\frac{3}{4}$ ".

Weight on driving wheels, 250,200 lbs.

Weight on front truck, 38,800 lbs.

Weight on trailer truck, 104,000 lbs.

Weight of engine, total, 393,000 lbs.

Weight of tender, 216,400 lbs.

Tank capacity, 12,000 gals.; 18 tons coal.

Diameter rear trailing truck wheels 45" booster driving wheels.

Piston valves, 14" diameter.



FIG. 12. — MODERN LOCOMOTIVES ON BOSTON & MAINE R.R.

Upper figure. Freight locomotive (2-8-4 type)

Lower figure. Switching locomotive (0-8-0 type)

One of the principal features of construction is the articulated main rod. With a piston thrust of 130,000 pounds, it is almost impossible to hold the engine in its boxes with standard rods when it is considered that but 25,000 pounds is the average box load. The Santa Fé locomotives have a similar condition, and it is not at all unusual for them to actually lift out of the boxes in a hard start when the engine is somewhat cold. To take care of this condition and reduce the attendant high mainte-

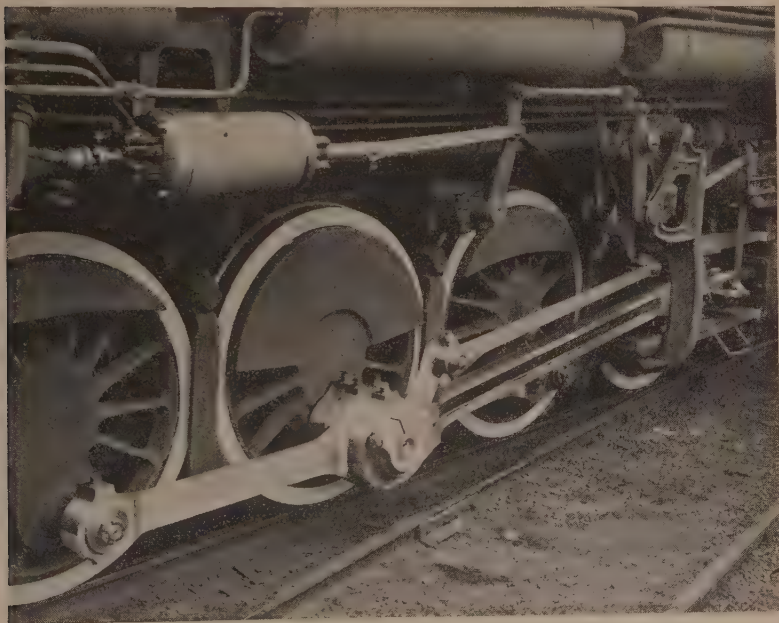


FIG. 13. — ARTICULATED MAIN ROD OF LOCOMOTIVE DELIVERING THRUST TO THIRD AND FOURTH PAIRS OF DRIVERS

nance, the main rod was forked so as to deliver the piston thrust to two main drivers instead of one.

Fig. 13 shows the construction in general outline. In this particular design the main rod is forked and delivers its thrust to the third and fourth pair of drivers, the side rod carrying the balancing force forward to the first and second pair of drivers.

In order to gain the advantage of a large grate area, it was necessary to go to a four-wheel trailer truck. Locomotives of twenty years ago had the fire box mounted between the frames, the grate area being necessarily limited. As locomotives grew in size, it was necessary to provide the

necessary boiler capacity, fire box and grate area being accordingly enlarged. This increase was made possible by the introduction of the two-wheel trailer trucks to carry this additional weight, the first Mikado locomotive being constructed in 1897. As railroad operation continued to demand more and more power from the locomotive, a point was reached some years ago where it became impossible to provide the necessary grate area without increasing the axle load on the trailer trucks. This led to the design of the four-wheel trailer truck, making possible a fire box having 100 square feet of grate surface. It is not at all unreasonable to predict that additional grate area may even bring forth a six-wheel trailer truck, although that is in the future.

One of the principal features affecting economy is the limited cut-off. This high-pressure limited cut-off design increases the capacity of the locomotive in two ways: First, by raising the starting power of the engine on account of the more even torque, which permits the use of more tractive effort for a given driver wheel weight; and second, it permits the use of steam more expansively than in an engine not having limited cut-off.

In actual tests, limited cut-off engines have developed a steam rate per indicated horse power of 20.4 pounds, as against 25.6 pounds for engines without limited cut-off. With the use of limited cut-off and large grate area, it is possible to "full stroke" the Lima engines up to 18 miles per hour. At this speed they are producing almost 4,000 horse power. If this power were represented by horses, hitched in a single line, it would stretch out over 7 miles. This power is controlled by only two men, the engineman and fireman.

The booster has been utilized to add power at low speed, so that the combined result is a practically constant increase over the full-stroke engine throughout the entire range of operation, from starting to full speed. Instead of designing the entire engine for the starting effort, it is possible, by means of the booster, to design the engine to deliver full efficiency at a higher speed, usually the working speed.

Fig. 14 shows in very concise form the advantages to be gained from adequate grate area, the Mikado (2-8-2 type), having but 66.4 square feet of grate area, gives steam plant efficiencies of from 62 to 73 per cent, while the Lima (2-8-4 type), with 100 square feet of grate area, gives steam plant efficiencies of from 75 to 84 per cent. This means a direct saving in fuel, and reflects itself in more economical operation; not only can the engine make longer runs between stops, but it does it more cheaply from a fuel standpoint.

The superheater area has been increased to 2,111 square feet. This,

together with the 121 square feet in the arch tubes and syphons, makes for a maximum superheat of a maximum steam output. The syphons and arch tubes increase the amount of steam produced; the superheater takes care of the necessary additional heat required to prevent condensation and effect steam economy in the cylinders.

The higher pressure in itself is a direct economy. The pressure used is as high as can be consistently operated with stayed surfaces. The only locomotives using higher pressures in this country are those equipped

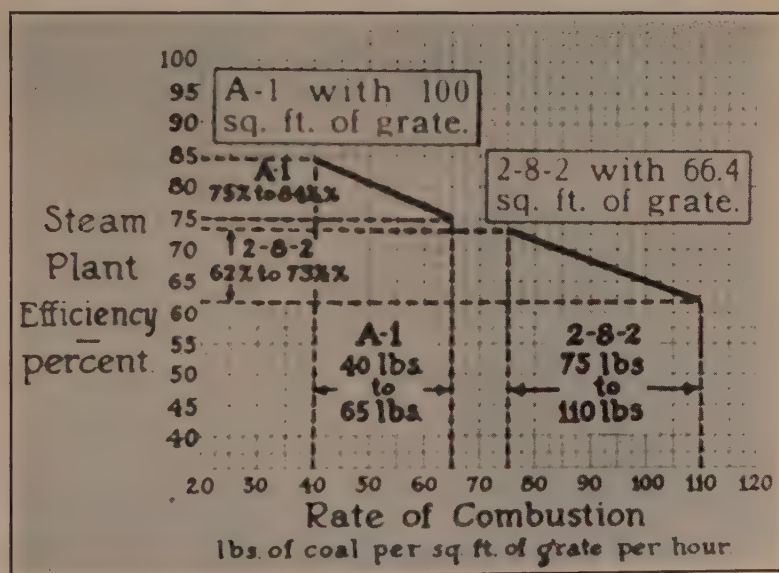


FIG. 14. — COMPARISON OF EFFICIENCIES OF TWO ENGINES WITH DIFFERENT GRATE AREAS

with water tube fire boxes. This limitation is one set by steel, and at the present time represents the latest development in this feature of design.

The gain in general economy may be best stated by comparing engines for the last two decades. In 1906 the representative engines of that day produced only 8,810 gross ton miles per train hour. In 1916 the improvement in design had raised this figure to 12,490 gross ton miles per train hour, while in 1925 this figure had been increased to 19,679 gross ton miles per train hour, with an increased speed of 11.8 miles per hour. These modern freight engines have produced as high as 60,000 gross ton miles per hour, a truly remarkable performance.

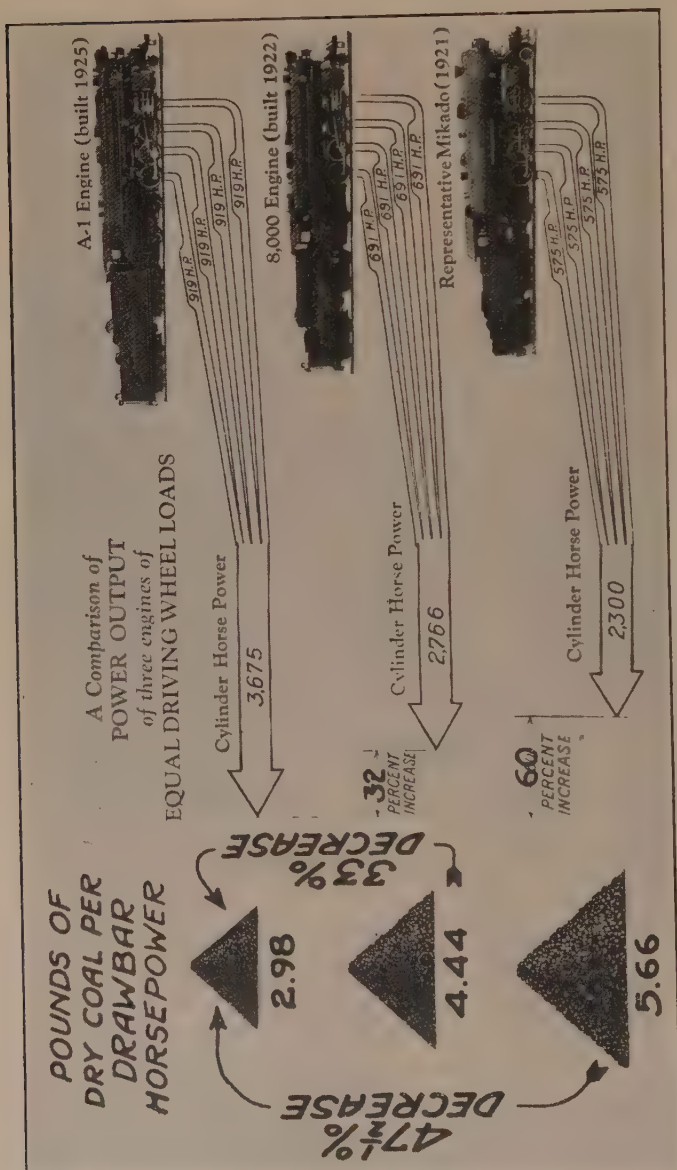


FIG. 15. — COMPARISON OF POWER OUTPUT OF THREE ENGINES OF EQUAL DRIVING WHEEL LOADS



Super-Power Locomotives in regular operation over a period of several months have reduced the unit cost of operation 25 per cent on one railroad.

How It Was Done

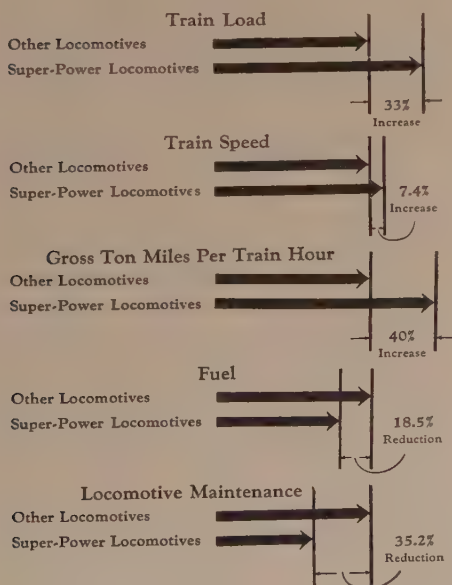


FIG. 16. — REDUCTIONS IN OPERATING COSTS USING SUPER-POWER LOCOMOTIVES

Fig. 15 gives in concise form a general idea of the increase in power, together with the better efficiency in coal consumption. From 5.66 pounds per drawbar horse power in 1906, this has been brought down to 2.98 pounds per drawbar horse power, a figure that compares favorably with modern power plants. The cylinder horse power in the meantime has been increased from 2,300 to 3,675 cylinder horse power.

Fig. 16 sums up the factors affecting the total economy. It shows the increase in train load, together with an increase in train speed, the two producing a 40 per cent increase in gross ton miles per train hour. This has been done with a decrease of 18.5 per cent in fuel and 35.2 per cent in maintenance. It knocks a large quarter out of every dollar of operating expense, making possible the handling of freight with more economy than ever before enjoyed. This economy is being reflected in better service, faster speed and surer "on time" delivery.

Discussion

QUESTION: Is the retarder shown the Hannauer retarder?

MR. RICHARDSON: Yes, President Hannauer was the inventor, and the retarders shown were built under his patents. There are two types, — the all-electric, built by the General Railway Signal Company, and the electro-pneumatic type, built by the Union Switch and Signal Company.

MR. J. R. NICHOLS:* Since Mr. Richardson didn't tell a story, I would like to tell one.

A gentleman of my acquaintance, who spent the summer in the northern part of Maine, wanted a keg of galvanized shingle nails from Boston, and wrote his office to have them sent in a hurry. They were to go to Mount Desert Ferry. His manager bought the nails and asked to have them sent by express because his employer wanted them in a hurry. The bright young woman in charge of shipping said, "Oh, if he wants them in a hurry I will send them by freight," which she did; and the nails arrived the next day.

QUESTION: I should like to ask whether the art of the car builder has been developed in corresponding amount to that of the locomotive builder? If the loads are heavier per car, does that mean that the cars have to be built on a different principle, in order that the retarders may not injure the wheels in the action of these hump yards?

MR. RICHARDSON: The load of the car doesn't affect the operation.

* Consulting Engineer, 45 Newbury Street, Boston, Mass.

Retarders will handle 70-ton cars as easily as a 20-ton empty car. The car is a rather simple structure. The principal advance in car design is an increase in capacity. Sixty thousand pound capacity cars were common twenty years ago. Ten years ago 100,000-pound cars came into use. Today we are using 140,000-pound cars. In Virginia they use 240,000-pound capacity cars. In New England we are trying to step from 100,000-pound capacity cars up to 140,000-pound cars. In developing the car capacity we have been confronted with an unusual number of limitations. The sidings were built many years ago. I should like to have Mr. Cummings say a word on the limitations he meets in handling the heavier capacity cars. They will mean, ultimately, lower cost to the shipper and more efficiency.

W. F. CUMMINGS:* It is a fact that on the Boston & Maine Railroad we have a great many clearance and curvature limitations, and it is going to be rather costly to eliminate them, but it must be done before we are able to handle these heavy capacity cars.

C. B. BREED:† Is it not true that previous to this past seven or eight years, during which period so great an increase in the amount and efficiency of power of freight locomotives has developed, there was a considerable increase in the tractive effort of locomotives which demanded greater freight car capacity? Steel underframes then came into use, as well as stronger designs for the drawbars and buffers. Those developments in car design preceded this recent development in locomotives. I think that the question as to whether the cars had to be redesigned to meet this recent power development is answered by that fact.

MR. RICHARDSON: To get an idea of the importance of that point, the value of Boston's terminals and the equipment located within the Boston area amounts to \$50,000,000, or 20 per cent of the Boston & Maine property. The Virginian Railway was built to produce transportation at the lowest possible cost. They did it with 50-ton cars. Later they found it necessary to increase the capacity, and did so by 60 per cent, simply by building 120-ton cars. With the same track space in a yard, and these heavy capacity cars, 60 per cent more tonnage can be handled. Sooner or later in New England we are going to be forced to heavier cars. The limitations of the yards are pretty well settled. The Boston terminals can't be expanded easily. There are streets and buildings all around them. To move them would cost a great amount of money. In time heavier cars will be required. We are progressing toward that now.

* Assistant Chief Engineer, Boston & Maine Railroad, Boston, Mass.

† Professor of Railway and Highway Transportation, Massachusetts Institute of Technology, Cambridge; and Consulting Engineer, 6 Beacon Street, Boston, Mass.

C. FRANK ALLEN:* It was my lot in 1892 to visit what I think was the first forerunner of the hump yard. It was a gravity, rather than a hump yard. It was at Edge Hill, just out of Liverpool. In those early days we had men riding on the cars in the yards and operating brakes, but when they, in this yard, wanted to retard the cars their method was to have a man run alongside with a lever in his hand and bring the retarding force against the wheels. The cars were the small English cars. There has been some progress since then.

I don't remember exactly the circumstances, but there were certain places where they had to look out for runaway cars, and they had a retarding device which was very interesting. There was a box in the middle of the track, and from that a huge hook extended, which would catch the axle of the car. Attached to the hook was a long stretch of heavy chain which played out and brought the car to a stop. The method of stopping by a constantly increasing retardation was really in principle extremely scientific, but of course crude in appearance. It had the additional advantage that it offered no temptation to the yardmen to make any mistake and have this device brought into action unnecessarily, because it was no small job to pull the chain back into the box where it originally belonged.

QUESTION: I would like to ask Mr. Richardson whether the "skate" machine which he referred to is a necessary device, and whether he predicts that it will be continued to be used extensively.

MR. RICHARDSON: The yards in Boston are not equipped with the skate machine. The skate is used to catch missent cars. Here, the number of such cars is almost nil. We use the stationary skate at the end of each track to prevent the car running over the lower switch and fouling it.

QUESTION: What do you do when a car is missent?

MR. RICHARDSON: We have the engine go in and take it out, after the string has been classified.

QUESTION: I think it might be interesting to hear more about the booster engine, particularly whether it cuts out automatically or whether they have to cut it out, and also what means are used to prevent the machinery from being a drag.

MR. RICHARDSON: The booster is a modern development and has made possible economical maintenance of the heavier locomotives. The Santa Fé type has five pairs of drivers. You take the thrust of the piston when the entire force is delivered to one crank. It amounts to 130,000

pounds. There is only 25,000 pounds on the bearing holding it. Those locomotives may rise out of their boxes, especially if the bearings are cold. So it is necessary to go back to four pairs of drivers to the engine. The booster was developed to supply the fifth driver. The additional power is only needed up to 8 or 10 miles an hour. The booster has gears that are thrown into mesh as the locomotive starts. The booster drives at a relatively high speed and gives considerable power. It will operate up to 8 or 10 miles an hour, at which speed it becomes unnecessary to deliver power by the booster. So the engineer, instead of using steam at 50 or 60 per cent, "hooks up" the latch that automatically throws the booster out of gear, and throws the driving gear back clear of the gear on the shaft. Of course a certain amount of dead weight hangs on the truck.

QUESTION: You spoke of the cut-off at 60 per cent. Is it a fact that in these new types of engines a long cut-off can be maintained with much higher speed than in the older types?

MR. RICHARDSON: This is true. This modern Lima locomotive is essentially a power plant. The older type of engine ran by bull strength. They could only full stroke up to 4 miles an hour. At 8 or 10 miles an hour they had to reduce the cut-off appreciably. In the Lima locomotive cut-off is limited to 60 per cent. It is practically as strong as previous locomotives built with 85 to 90 per cent cut-off. It is possible to full stroke the Lima locomotives up to 18 miles per hour.

J. B. BABCOCK:* I recently had an opportunity to visit the Boston & Maine yard at Mechanicville, New York. To those familiar with the earlier type of hump yard operated by car riders this new retarder-operated type will furnish a surprising contrast. The first impression is that there is nobody around — just a string of cars slowly appearing over the hump, the cars then drifting silently down the classification tracks. A second glance discloses two men at the hump, one supervising the humping and checking the "cut" lists, and the other actually cutting the cars; and in each tower an operator who controls the switches and the car retarders. The single switch engine at the hump end of the yard pushes the strings of from 80 to 100 cars over the hump, takes cars out for icing on the refrigerator tracks, delivers those destined for the "rip" (repair) tracks, and does other miscellaneous switching. Very soon after a train arrives from the West the teletype machines begin "clicking" in the retarder towers, giving the track destinations of the cars in that train, and in just a few moments the string of cars comes leisurely over the hump.

* Professor of Railway Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Formerly some yards had both a winter and a summer hump; in others, the hump was boosted up in the winter. This was necessary in order to provide steeper grades to overcome the increased rolling resistance of the cars in cold weather. The Boston & Maine overcomes this difficulty at the hump by spraying hot oil into the journal boxes during the cold weather.

It is interesting to watch the cars "drift" down the yard — and drifting is just the word to describe it. The operation of the car retarders to allow each individual "cut" of one or more cars the proper speed as it leaves the last retarder requires expert work on the part of the man in the tower. The empty cars, with a rolling resistance of $6\frac{1}{2}$ or 7 pounds per ton, and the loaded cars, with a resistance of $3\frac{1}{2}$ or 4 pounds per ton, must leave the retarders at quite different speeds in order to reach the lower end of the yard at safe coupling speeds. If the empty doesn't leave the retarder with a reasonable speed it will "stall" part way down the classification track and an engine will have to go down after it, whereas if the heavily loaded car is not brought almost to a stop in the last retarder it will pick up too much speed and hit the cars at the lower end of the yard with more of a shock than is good for the equipment. Careful design of the grades through these yards is necessary, particularly the flattening of the grades on curves, to allow for the increased resistance due to curve friction.

Some of the following operating statistics of the Boston & Maine Railroad may be of interest:

	1924	1927	1928 (First Eight Months)
Average net tons per train	486	526	588
Average car speed per day	19.0	22.7	25.5
Gross tons per train	1,185	1,331	1,526
Gross ton miles per train hour	12,575	14,750	17,635
Net ton miles per car day	276	321	347
Pounds of coal per 1,000 gross ton miles	153	127	122

These figures indicate clearly the operating improvements which have been made, particularly those for the first eight months of 1928. These results amply justify the title of Mr. Richardson's paper, "Fast Freight Transportation."

QUESTION: I would like to ask Mr. Richardson about the life of

locomotives. How long are they efficient? Do they grow obsolete before they are worn out?

MR. RICHARDSON: They become obsolete in terms of life rather than age. The New York Central would be glad to sell locomotives built as late as 1922. If it could get even a fraction of the original cost it would be grateful. On the other hand, some locomotives twenty and thirty years old are still giving very good service. These are mostly the light branch line locomotives. You can extend the life of a locomotive indefinitely by repairing it. New fire boxes, new boilers, new tires, etc., accomplish this.

C. B. BREED: I recall that you had retired two Mallet engines on the Boston & Maine.

MR. RICHARDSON: Those engines were only six years old.

J. B. BARCOCK: It may be interesting to note how important it is to build locomotives that can be maintained at a reasonably low cost. At the present time — and this is in no way criticism of the Boston & Maine — repairs to locomotives cost about the same amount as does the fuel used in road and yard service.

C. B. BREED: The passenger train hasn't been spoken of tonight. It hardly comes under the heading of the paper, but it may be of interest to know that the "Flying Yankee" leaves Portland at 5.50 and arrives in Boston at 8.10, thereby exceeding the average speed of the "20th Century."

QUESTION: Are there any scales or weighing devices used in the yards, or are the cars just classified?

MR. RICHARDSON: That depends a good deal on the business the hump is required to handle. Many humps have scales right on the hump, and as the cars pass over they are weighed. These modern scales are almost human; in fact, better than human, because they weigh automatically, quickly and accurately. The scale is tested at regular intervals and is accurate to the fraction of a per cent. Those scales can weigh cars, and many are equipped to actually stamp the weight on the weigh bill as the car goes by.

QUESTION: Can the cars go over the hump at the same speed if they are weighed?

MR. RICHARDSON: They usually pass over the scale at about two miles an hour. The hump can be designed so that as the cut breaks they will pass at two miles an hour. You can't get maximum capacity from a hump with the scale on it. A hump with a scale on it is slower in working.

QUESTION: Is it true that if the scale is in operation only, it slows up the car? How is it if the track is dead?

MR. RICHARDSON: If the track is dead it does not slow up the car. Only when the scale is used.

QUESTION: What practical use can you make of that weight?

MR. RICHARDSON: The weight is noted by the scale master, and the tare weight is deducted from the gross weight to get the net.

QUESTION: I would like to ask whether the speed has increased since the introduction of the hump?

MR. RICHARDSON: Train speed has been increased, particularly on the through fast trains. Three years ago the fastest schedule between Mechanicville and Boston was 13 hours and 15 minutes. In 1926 it had been cut to 12 hours and 15 minutes. Today "The Hubber" (to Boston) leaves Mechanicville at 6.30 P.M. and is humped in Boston at 4.30 A.M., — 10 hours. At that it usually arrives half an hour ahead of time. Those cars leaving Mechanicville at 6.30 at night are all on the bulk track before 7 A.M. the next morning. You can ship freight out of Boston and reach practically any point in New England the next morning. There is a train for Mechanicville that leaves Boston about 6.30, reaching Mechanicville early in the morning. The train for Portland is very fast. It leaves Boston and runs through to Portland in four hours. The cars are so classified, that cars going upstate in Maine are put on the front end of the train and those for Portland are at the rear end. It is no trick at all to ship freight out of Boston at night and have it pretty far upstate in Maine the next morning.

QUESTION: I would like to ask if there is any special preparation for taking care of ice and snow in the operating of the retarders?

MR. RICHARDSON: The earlier retarders were first installed on Gibson hump and tried out in summer. Winter conditions didn't affect them at all. There was no difficulty. The engines are now equipped with snow blowers which consist of castings with nozzles pointed away from the front of the engine with a 2-inch steam line leading to them. They blow everything ahead of them. One engine can easily blow all the snow out of the switch and the retarders in about ten minutes. They don't try to melt it. They just blow it out.

Fog may cause trouble in some yards. In Boston this is not the case. It is entirely possible in the Mississippi Valley, for instance, where the fog lies very thick, to get into trouble from it. Boston is one of the most fog-free ports in America.

The lighting of these yards is quite important. There is usually a big battery of searchlights located on a high tower. This throws light

just above the head of the tower operator, so it doesn't cast a glare in his face, and illuminates the entire yard. If you are up around the Washington Street bridge at night you can see every car without difficulty.

MR. J. R. NICHOLS: Warehouses in Boston and in other eastern cities used to do a good business in the storage of raw materials brought from the West for manufacturers here and manufactured goods stored for merchants. When the manufacturer or dealer bought his goods in the West he had them shipped east, and stored here, because then he knew he could get them when wanted.

Now the warehouses in Boston and in most eastern cities are fairly empty. The chief reason seems to be that the goods are left out West and the manufacturer when he wants them orders shipment, knowing accurately within a day or two how long it will take for the goods to come. The high quality of performance of the railroads in the last six years, in respect to freight transportation, has depleted warehouse stocks and brought hard times to public warehousemen. I should like to ask Mr. Richardson if he foresees any likelihood of relief from this depressing situation?

MR. RICHARDSON: I doubt it seriously, because of the development in the warehouse game that is rather common in the West, but new in New England; that is, the terminal warehouse, built over the track. By reason of that you can ship a carload of freight into Boston and distribute in small lots without trucking. The freight comes into the warehouse with no trucking cost. Outbound, it goes into an elevator to the freight platform. This eliminates trucking from the inbound track to the warehouse and a second trucking to the outgoing. There is now a large development of that sort over in East Cambridge.

C. B. BREED: In other words, the railroads have gone into the warehouse business as well.

QUESTION: Of course these retarders and other facilities for speeding up the hump yards have meant that a given amount of trackage, etc., will take care of a good deal more business, and, incidentally, equipment. Would you set any stated limit in yard capacity, in cars, or in the tons per day that a yard must handle, or any limitation that you like where retarders would be or would not be warranted?

MR. RICHARDSON: That depends entirely on the yard set-up. Roughly speaking, when the yard passes 1,000 cars per day you are in the zone where full retarder equipment would be economical. In some yards, where there are only four or five classifications, you could economically equip with two or three retarders. Such a case is White

River Junction. That is not a full retarder installation. They plan to use three or four retarders. That yard handles only 400 or 500 cars a day, and yet the use of retarders is going to be economical. Retarders are finding their way into smaller and smaller yards. In general, you can cut the cost. Take it at Mechanicville — the car cost has been cut from \$1.10 to 60 cents per car. At White River Junction, with only 500 cars a day, it is going to pay handsomely, so the lower limit as to the use of retarders is difficult to set. It used to be 1,000.

OF GENERAL INTEREST

SOIL-CORROSION STUDIES

Preliminary Report by the Bureau of Standards

The Bureau of Standards has issued a preliminary report on the results of its soil-corrosion studies, started in 1922, which contains a large amount of valuable information for engineers, particularly those connected with public service organizations. The investigation is being carried on in co-operation with manufacturers, public utility corporations, several governmental departments, and the various interested technical societies. The materials considered in the investigation include various kinds of steel, cast steel, cast iron, wrought iron, wood fiber, lead, brass, copper, bronze, aluminum, zinc, and pipe, as well as metallic and non-metallic coatings for steel and iron. There were approximately 14,000 specimens buried in 47 different types of soil. At present only 2,000 of these specimens have been removed, and therefore this report is only a preliminary indication of the final results. Specimens are being removed at two-year intervals, and so the investigation will probably not be completed for some years.

The specimens in general consist of short lengths of pipe ranging from $1\frac{1}{2}$ to 6 inches in diameter and 6 inches long. Specimens were removed from the test soils at intervals of approximately two years, and were classified in accordance

with the loss of weight due to corrosion and the depth of the corrosion. The data obtained up to the present indicate the following:

1. Corrosion depends upon the type of soil. Well-drained, coarse-grained soils show less corrosion than wet silty soils. The most corrosive soils were those with a high per cent of sulphates (white alkali) and heavy soils with a slight acid reaction.

2. The majority of soils have a low rate of corrosion. In some cases it is practically negligible, while several soils have appreciable corrosion.

3. The type of corrosion differs from the several soils. In alkali soils corrosion occurs in large patches; in heavy, clayey soils it took the form of small pits; and in one soil the specimen appeared as if worm eaten.

4. The rate of corrosion appears to decrease with the time of exposure.

5. No one ferrous material appears to be superior to all others for use in all soils.

6. Bituminous coatings in general do not furnish sufficient protection against corrosive soil conditions.

7. Copper and its alloys corrode very slowly. Lead and zinc pit badly in some soils, and aluminum very rapidly in certain soils.

MEMOIRS

Henry Sewall Adams*

DIED AUGUST 21, 1927

HENRY SEWALL ADAMS, son of Charles Sylvester and Christiana Wyman (Jennison) Adams, was born in Cambridge, Massachusetts, March 16, 1864. At an early age he lost his parents, as well as his only brother and sister, and his boyhood was spent with his Grandfather Adams in Cambridge, and at the farm of his Grandfather Jennison in Burlington, Massachusetts.

At the age of seventeen Mr. Adams began his engineering career with a survey party on the sewerage system of Woburn, Massachusetts, work which occupied four summer vacations during his course at the Woburn High School and following his college freshman year. In 1883 he entered the Massachusetts Institute of Technology where he studied civil engineering with the class of 1887, leaving, however, before graduation, to take a position in the office of the city engineer of Cambridge.

Municipal engineering work in Cambridge and work as assistant county engineer of Middlesex County occupied Mr. Adams until 1893 when he opened his own office in Boston for the private practice of engineering, a practice which was continued uninterruptedly until his death. At first, his office was in the Exchange Building at 53 State Street, and later, and until his death, in the Ames Building, corner of Court and Washington streets.

In the early years of his private practice, Mr. Adams' professional work included water-front developments at Boston, reporting on mines in Montana, Idaho, California and Mexico, and on

other properties in different parts of the country. He also for a short time, in company with a classmate, engaged in gold mining on his own account. In 1895 was begun the construction of Boston's subway system, the pioneer undertaking of its kind in the United States. This extensive work of underground construction presented new and unusual problems of the underpinning and safety of buildings. In the several years during which subways and tunnels were being built in down-town Boston, Mr. Adams, more than any other engineer, was called upon by private clients to advise on these foundation problems, and to look after the safety of over one hundred important buildings.

Gradually work on difficult foundations and more particularly that in connection with the building of water-front structures came to absorb Mr. Adams' attention. In this special field he made a reputation which was not confined to Boston. Not only did he come to be looked upon as the leading engineer in private practice on the development of the Boston water front, — and no engineer has been more closely identified with private developments at that port, — but his services were in demand elsewhere. He was one of two engineers commissioned by the city of Newark, New Jersey, in 1909, to study and report upon the layout of the port development of the Newark Meadows; he designed wharves and docks for Ponce, Porto Rico; he designed and supervised the building of the Sandy Bay improvements at Rockport, Massachusetts; and he was engineer on harbor and water-front improvements at other ports.

For many years, until his death, Mr. Adams was consulting engineer to the Atlantic Sugar Refineries, Limited, of Montreal, on its water-front plant at St. John, New Brunswick, where his

* Memoir prepared by Frederic H. Fay and Henry F. Bryant.

advice was sought not only on difficult water-front problems, but also upon the general development and upkeep of the plant. Likewise, for many years he was consulting engineer to the Pocahontas Fuel Company, Incorporated, in connection with its coal-handling plants at Portland, Maine, and at New Bedford, Massachusetts. At both Portland and St. John he successfully met some unusually difficult problems of water-front construction in connection with structures, previously built by others, which had failed. Many fuel companies engaged his services in connection with the building and repair of coal-handling plants. Included among his clients were railroad and steamship companies and many corporations, as well as most of the private wharf owners along the Boston water front.

Mr. Adams showed peculiar ingenuity and resourcefulness in solving problems of unusual difficulty and complexity. Painstaking and thorough in his work, he was also a man of broad outlook and sound judgment. By his clients, many of whom he served continuously over a period of years, his advice was sought, not alone on structural problems, but also on the conduct of business.

For more than thirty years, and until his death, Mr. Adams lived in Arlington, a suburb of Boston. He retained also the farm of his Grandfather Jennison in Burlington, where part of his boyhood had been spent, and in which he always took a special interest. He served the town of Arlington in many ways. During the early years of his private practice, and until the appointment of a full-time town engineer, he acted as engineer for the town and took an important part in the laying out and development of this growing community. He was elected a member of the Board of Public Works of Arlington in 1912, a position which he filled for several years, part of the time being chairman of the Board. He was elected a member of the

first Planning Board of the town in 1914.

Being deeply interested in historical and genealogical matters, he was long an active member of the Arlington Historical Society as well as of the Bostonian Society.

Mr. Adams was admitted to membership in the Boston Society of Civil Engineers October 19, 1892, and served as a Director of the Society in 1925 and 1926. He was a life member of the International Association of Navigation Congresses; a member of the American Society of Civil Engineers; a member of the American Society for Testing Materials; and of the Association of Professional Engineers of the Province of New Brunswick, Canada. He was a member of the Engineers Club of Boston and of the Boston Chamber of Commerce, in which latter organization he took an active part in the work of the Maritime Association.

In October, 1892, Mr. Adams was married to Bessie Lockwood Tucker of Cambridge. He is survived by his widow and four sons, Charles Jennison, Laurence Wilder, Ralph, and Henry Sewall, Jr. There are also two grandchildren, Jane and Charles Jennison, Jr.

By ability and achievement he worthily earned a position of standing in the engineering profession. Ever modest, genial, and true to his own high standards, he endeared himself to a wide circle of friends and associates. Especially was he held in high regard by the clients whom he served. One of them writes:

Mr. Adams had the happy faculty of always impressing his client with explicit confidence in his judgment, and I never knew a more careful and painstaking man than he when he had a difficult problem confronting him, and he had one of the most lovable natures that I ever knew in a man of his ability. Our company has suffered a great loss in the death of Mr. Adams.

Another client says of him:

The recital of Henry S. Adams' services to this company would be a long and unbroken record of valuable contributions. He possessed an engineering ability that in itself was sufficient to distinguish him, but over and above this was a pride and joy in his work and a simple devotion to an ideal which, combined with his professional ability, gave him that place and position which he occupied so well. Possessed of a delightful modesty, and never superior to gaining information from whatever source it might be offered, he none the less inspired full reliance by his own quiet confidence.

It is, however, impossible to consider Henry S. Adams except it include his own charming and lovable character. The start of our business relationship marked also the beginnings of a personal attachment which grew and deepened until it became one of life's delightful realities. It is a great privilege to have had him as a friend and to continue him in our affectionate remembrance.

An able engineer and useful citizen, Henry Adams was a lover of Nature, a devoted husband and father, and a loyal and understanding friend.

Bertrand Thorp Wheeler *

DIED MARCH 20, 1928

BERTRAND THORP WHEELER was born in Lempster, New Hampshire, on November 25, 1863, the son of Daniel Bingham and Maria Wheeler. His boyhood days were spent in Cambridge, Massachusetts, where he attended the public schools until he reached the age of fifteen. In 1879 he entered Dartmouth College at Hanover, New Hampshire, where he took a scientific course, and was graduated in 1884 with the degree of Bachelor of Science.

Mr. Wheeler's first employment was in 1885 as rodman with the Old Colony Railroad Company, now part of the New Haven System. In 1886 he was made first assistant to the chief engineer of the "Old Colony," which position he held until 1895. During this period he had charge of second-track construction, grade separation, and other minor work. He originated and promoted the plans for separation of grades at West Fourth Street, Boston, Massachusetts, involving a new bridge over Fort Point Channel which was among the first works of this character accomplished in Massachusetts.

From 1895 to 1896 and from 1900 to 1901 Mr. Wheeler held the office of superintendent of streets for the city of Boston under the Republican administration of Mayors Curtis and Hart, making a splendid record in this onerous position. He was engaged in private practice from 1896 to 1900.

In 1902 he entered the service of the New York, New Haven & Hartford Railroad Company as assistant engineer of construction, which position he held until 1907, when he was made engineer of construction. During this period he had charge of the work in connection with the elimination of grade crossings at Dudley Street, and Savin Hill to Neponset (Boston), Hyde Park, Attleboro, Worcester, and other points.

From 1910 to 1912 Mr. Wheeler was also engineer of construction of the Boston & Maine Railroad Company. On November 1, 1912, he severed these connections and accepted the office of chief engineer of the Maine Central Railroad Company (succeeding the late Mr. T. L. Dunn), taking up his residence at Portland, Me. He was also chief engineer of the Portland Terminal Company, a subsidiary of the Maine Central. In this position he was responsible for the condition of right of way and structures

* Memoir prepared by A. H. Morrill.

on more than 1,100 miles of road, for property valued at nearly \$50,000,000, and at times he had more than 3,500 men working under his direction.

During his service as chief engineer of the Maine Central Railroad, the line was extensively modernized and many new structures were created under his direction, some of the more notable of which were the double-tracking of the main line between Clinton and Waterville, Maine, the erection of railway bridges across the Kennebec River at Augusta and Fairfield, and the construction of the Rigby Terminal Yards, in South Portland, Maine.

Mr. Wheeler was a man of brilliant intellect, sound sense, and good judgment, possessing a rare faculty of analyzing a problem or looking over a plan and intuitively picking out any flaws it might contain. He was noted for the courage of his convictions and would stand by his guns under fire. His intolerance of incompetency, the bluntness and directness of his judgments, and his ever-constant desire for results often caused him to be misjudged by those who did not know him intimately. His associates and employees could see farther than the rather brusque exterior of the man, recognizing and prizing his uniform and constant justice, impartiality, and loyalty. Among them the feeling of sadness for a friend departed is tem-

pered by the thought that his work and his memory will long endure.

Mr. Wheeler had not been in the best of health for two years previous to his death. On February 22, 1928, he was operated on for sinus and antrum trouble at the Maine Eye and Ear Infirmary, in Portland. Although he rallied from the operation, the respite was brief and he failed gradually, passing away on March 20.

In 1888 he was married to Mabel Cole, the daughter of George H. Cole, proprietor of the American House, at Fitchburg, Massachusetts, by whom he is survived. He also left six children, Bertrand C. Wheeler of Chicago, Illinois, Allan T. Wheeler of Wellesley Hills, Massachusetts, Donald B. Wheeler of Buffalo, New York, Mrs. Warren B. King, Mrs. Theodore K. Thurston, and Miss Ruth Wheeler of Portland. Mr. Wheeler was always a devoted family man and took great interest in his summer home which was beautifully located on Great Diamond Island in Casco Bay, near Portland.

He was a member of the Dartmouth Club of Boston and the Massachusetts Society of Colonial Wars and Sons of the American Revolution.

Mr. Wheeler was elected a member of the Boston Society of Civil Engineers on March 20, 1895.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

OCTOBER 17, 1928. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, Boston, and was called to order by the President, Charles B. Breed, at 7.15 P.M. One hundred and twenty members and guests were present.

The reading of the minutes of the previous meeting (September 26, 1928) was omitted.

The Secretary reported the names of those elected by the Board of Government to membership in the Society, as follows:

Grade of Member: Michael A. Carchia,* H. Kenneth Fairbanks, Vernald W. Fox,* Ernest Mathers,* Daniel Martin Moore, Frank H. Packard, Jr., Lermond F. Simonds.* *Grade of Junior:* William Hickey, Ernest L. Proud.

It was voted that By-Law No. 8 be amended by omitting the last two sentences and substituting the following:

New members elected during the period from the close of the annual meeting to June, inclusive, shall pay full year's dues; members elected during the period from July to December, inclusive, shall pay one-half year's dues for that fiscal year; members elected during the period from January to the annual meeting, inclusive, shall be exempt from dues during the remainder of that fiscal year. The fiscal year shall commence at the close of the annual meeting.

It was Voted:

That the Board of Government be authorized to use the income from the Permanent Fund for the current year to such an extent as they deem necessary in payment of the current expenses of the Society.

These two matters had been acted upon favorably at the meeting of the Society on September 26, 1928, and the affirmative vote at this meeting made action on these matters final.

The President then introduced Mr. Lawrence Richardson, Mechanical Superintendent, Boston & Maine Railroad, who gave an illustrated talk on "Fast Freight Transportation." He discussed modern yards operated with car retarders and modern locomotives, with particular reference to the improvements made recently by the Boston & Maine Railroad.

The paper was followed by an interesting discussion during which Mr. Richardson answered numerous questions.

The meeting adjourned at 9 P.M., after a rising vote of thanks to Mr. Richardson for his courtesy in presenting this paper.

J. B. BABCOCK, *Secretary.*

APPLICATIONS FOR MEMBERSHIP

[November 20, 1928]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will

* Transferred from Grade of Junior.

assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

BROWN, CHARLES KENNETH, Amesbury, Mass. (Age 20, b. Amesbury, Mass.) Am a junior at Northeastern University and during the co-operative periods have been employed by the Essex County engineer, the town of Framingham and the Commonwealth of Massachusetts. Refers to *H. B. Alvord, C. O. Baird, J. W. Ingalls, W. E. Nightingale*.

CALDERARA, ORALL JOSEPH, Gardner, Mass. (Age 19, b. Barre, Vt.) Became a student at Northeastern University in the fall of 1926. During the co-operative periods has been employed as inspector on sewer construction with McClintock & Woodfall; rodman for J. J. Van Valkenburgh; rodman for Sweet & Kendall of Gardner, Mass.; assistant to city engineer of Gardner; and transitman for the city of Waltham. Refers to *W. J. Alcott, H. B. Alvord, J. W. Ingalls, W. E. Nightingale*.

CARROLL, JOHN ROGER, Pittsfield, Mass. (Age 33, b. Woonsocket, R. I.) Educated in the public schools of Woonsocket; two years in Rhode Island State College; two years of architectural construction and design at Wentworth Institute. Experience as follows: rodman with Eastern Construction Company, summer of 1916; as timekeeper and engineering assistant with General Construction Company of Woonsocket, summer of 1917, also five months in 1919; 1919-21, as transitman with city engineer of Woonsocket; 1922-23, draftsman in construction department; 1923-26, engineering assistant to city engineer of Pittsfield; 1926-28, assistant civil engineer in New Jersey State Highway on viaduct con-

struction; 1928 to date, construction engineer with R. W. Emerson. Refers to *R. W. Emerson, A. A. Fobes, E. A. Varney, W. C. Voss*.

COHEN, DAVID, Roxbury, Mass. (Age 21, b. Russia.) Is a student at Northeastern University. Refers to *W. J. Alcott, H. B. Alvord, C. O. Baird, J. W. Ingalls, C. T. Platter*.

HESS, FRED E., Flushing, N. Y. (Age 21, b. Flushing, N. Y.) Is a student at Northeastern University and has been employed during co-operative periods by Shapiro Construction Company and the town of Milton. Refers to *W. J. Alcott, H. B. Alvord, C. O. Baird, J. W. Ingalls, C. F. Joy*.

GREGORY, KARL, Norwalk, Conn. (Age 21, b. Norwalk, Conn.) Graduated from Norwalk High School in 1925 and became employed by Samuel M. Hoyt, Jr., Company as chairman in September of 1926. Is now a student at Northeastern University in civil engineering. During vacations and co-operative periods has been in the employ of S. M. Hoyt, Jr., Company. Refers to *W. J. Alcott, H. B. Alvord, J. W. Ingalls, W. E. Nightingale*.

HULSMAN, KENNETH GRAHAM, Everett, Mass. (Age 26, b. Somerville, Mass.) Graduate of Northeastern University in 1924. Employed by Aspinwall & Lincoln during co-operative periods as resident engineer for Pan American Petroleum and Transportation Company, 1924-26, one year being spent in construction work in New England and one year in southern states; year of 1928 with Dwight Building Company as assistant estimator and foreman of construction; in May, 1928, became draftsman and designer on marine railway work for Crandall Engineering Company, and with them to date. Refers to *H. B. Alvord, J. S. Crandall, J. W. Ingalls, R. H. Lindgren, W. E. Nightingale*.

WILLIS, LAURENCE HOUGHTON, East Bridgewater, Mass. (Age 19, b. East Bridgewater, Mass.) Graduate of East Bridgewater High School and now a student at Northeastern University. This past summer has been employed on a power development survey at North Conway, N. H. Refers to *W. J. Alcott, H. B. Alvord, C. O. Baird, J. W. Ingalls*.

For Transfer from Grade of Junior.

CROSSMAN, HARTWELL H., Attleboro, Mass. (Age 28, b. Norton, Mass.) Graduate of Northeastern University, 1923. From 1919-23, during co-operative periods, was employed by Aspinwall & Lincoln; from August, 1923, to March 30, 1926, with construction engineer, Southern New England Railway Company; from March 30, 1926, to date, at the office of receiver of Southern New England Railway Company in liquidation of railway property. Refers to *H. B. Alword, L. A. Chase, J. W. Ingalls, W. E. Nightingale.*

HOWE, JOHN A., Swampscott, Mass. (Age 26, b. Brighton, Mass.) 1919-21, employed in order department of Carnegie Steel Company; 1922, cost work and material chasing with Somers & Drisko, builders; 1923, with New England Structural Company on shop details, office and industrial buildings; 1924, with C. B. Roberts Engineering Company on design of mill buildings; 1924 to date, with Stone & Webster, Inc., on design of steel in connection with power plants and transmission lines. Refers to *S. K. Cohen, Hyman Felderman, J. C. Nowell, Jr., Dean Peabody, Jr., R. G. Stafford.*

RUBIN, BENJAMIN, Roxbury, Mass. (Age 27, b. Boston, Mass.) Entered Northeastern University in 1919 and graduated in 1923. During his college course was employed by George T. Sampson, Whitman & Howard, Aspinwall & Lincoln, and Public Works Department of Massachusetts. Upon completion of school work he entered the employ of the Metropolitan Sewerage Works as as instrumentman, and is at present a

junior engineer in charge of construction. Refers to *H. B. Alword, F. L. Flood, R. W. Loud, H. T. Stiff.*

WYNER, HENRY I., Allston, Mass. (Age 26, b. Boston, Mass.) Graduate of Northeastern University in 1925 and during co-operative periods was employed as rodman, transitman and inspector by Walter B. Foster, C.E.; sewer layout and construction; assistant in civil engineering department at the University; from July to November, 1924, as rodman and draftsman in Massachusetts Highway Department; 1924, as transitman with W. H. Whiting Company on land development; January to June, 1925, with Farnum & Gleason as transitman; July, 1925, through November, transitman in Department of Water, Metropolitan District Commission; in December, 1925, entered the employ of the National Waterproofing Company of Boston as estimator and civil engineer, and holds this position to date. Refers to *H. B. Alword, C. O. Baird, W. H. Gleason, J. W. Ingalls, H. C. Sheils.*

NEW MEMBER

Junior

ERNEST L. PROUD, 8 Bartlett St., Beverly, Mass.

DEATHS

GILBERT S. VICKERY . July 2, 1928
 PETER SCHWAMB . Nov. 3, 1928

BOSTON SOCIETY OF CIVIL ENGINEERS

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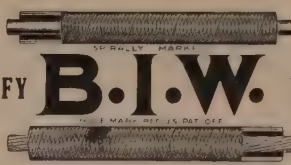
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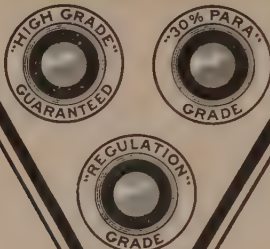
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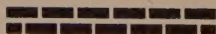
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